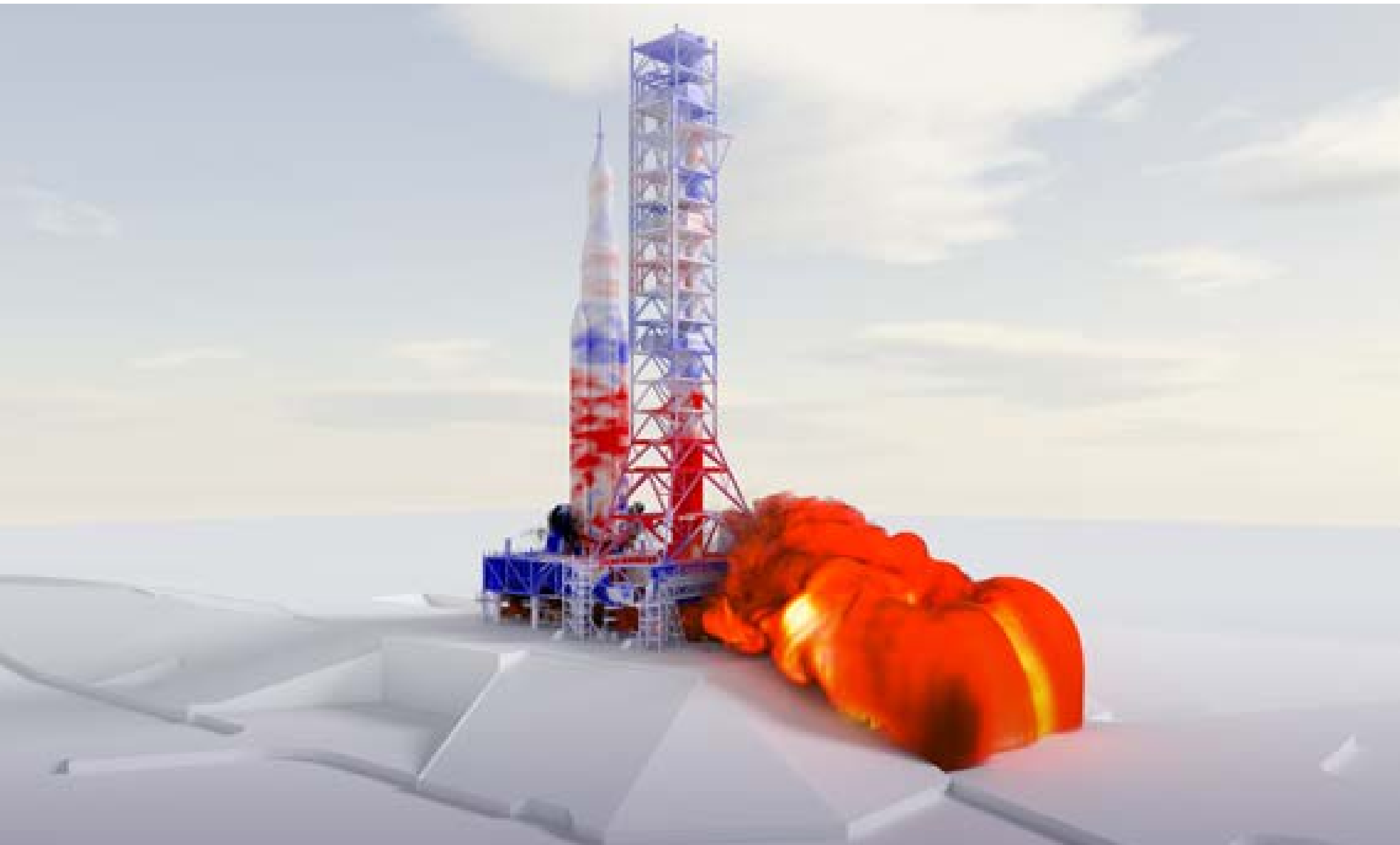
National Aeronautics and
Space Administration



NASA EXPLORES
Launch Vehicle Analysis

As one of the agency's premier aerospace numerical modeling and simulation resources, the NASA Advanced Supercomputing (NAS) Division has supported NASA space exploration missions for more than three decades. Computational fluid dynamics experts in the Computational Aerosciences Branch perform critical modeling and simulation to support development of NASA's Space Launch System, Orion Spacecraft, and launch environments for the Artemis Program and commercial space exploration missions beyond low-Earth orbit.

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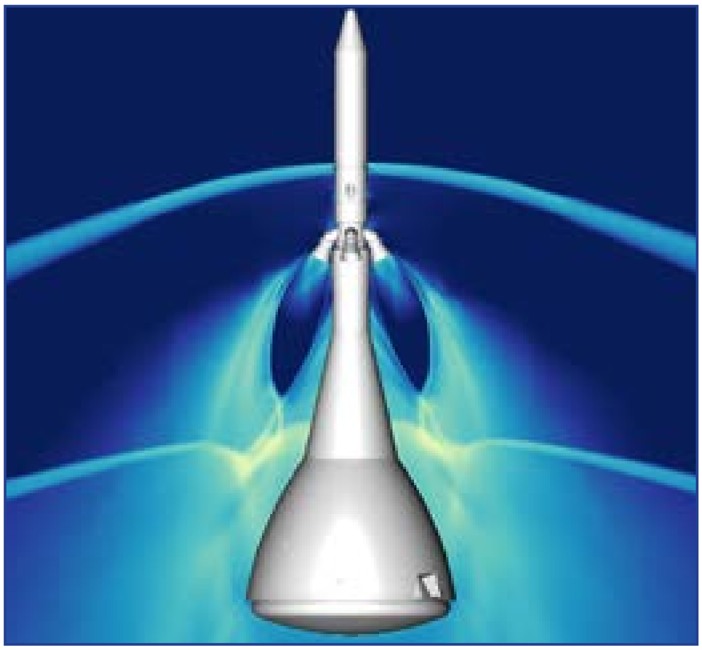
NASA ADVANCED SUPERCOMPUTING (NAS) DIVISION

Launch Environments

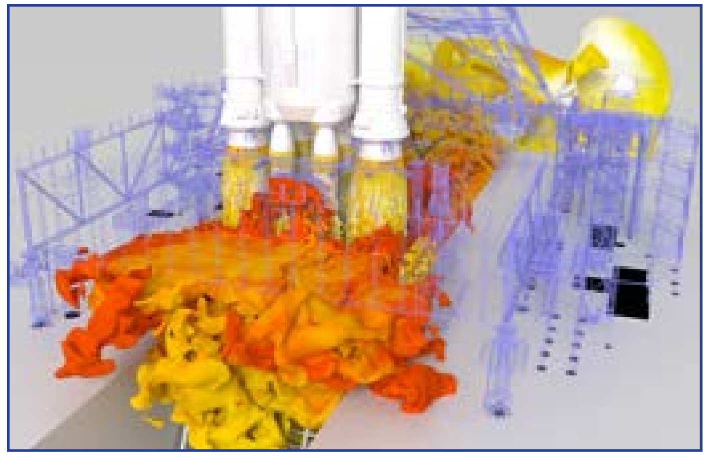
To prepare for launching modern rockets from NASA's Kennedy Space Center (KSC), including the Space Launch System and a range of commercial vehicles such as the SpaceX Falcon, engineers completely redesigned the main flame deflector at KSC's Launch Complex 39B to bring it up to date from the Space Shuttle era. Early in the process, NAS computational fluid dynamics (CFD) experts supported the redesign by applying their high-resolution Launch Ascent and Vehicle Analysis (LAVA) software to help analyze temperature, pressure, and flow on and around the geometry of the launch structure. The team is currently developing new multiphase simulation capabilities that will provide a more complete picture of the extreme conditions the launch system experiences.



Simulation predicting for overall sound pressure level of the Orion Ascent Abort Test 2 using 1.2 seconds' worth of volumetric data (nearly 5,000 snapshots). The cut plane through the vehicle's nozzles shows areas of pressure fluctuations that can cause vibrations on Orion's Launch Abort System structure (white is high, dark blue is low). Francois Cadieux, Timothy Sandstrom, NASA/Ames

Space Launch System

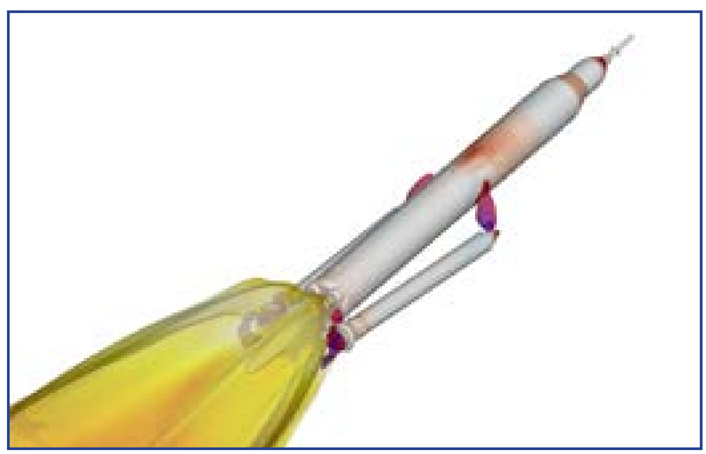
Using CFD, researchers at NAS have supported both the development of NASA's Space Launch System and related wind tunnel tests by running simulations using the agency-developed FUN3D, OVERFLOW, LAVA, and PEGASUS software to quantify the aerodynamic forces for multiple launch scenarios–from ascent through booster separation. The team has created many aerodynamic databases that provide crucial data for design engineers, including booster separation databases for Artemis II, which will send humans to near-lunar space for the first time since the end of the Apollo Program. These databases are used by the Guidance, Navigation, and Control group at NASA's Marshall Space Flight Center to help ensure a successful Artemis II launch.



Snapshot from a simulation of launch ignition for NASA's next-generation Space Launch System. Surfaces are colored by pressure (red is high; blue is low) while particles are colored by temperature (orange is hot; black is cooler). Michael F. Barad, Timothy Sandstrom, NASA/Ames

Orion Launch Abort System

In the event of a problem during an Artemis mission launch, Orion's Launch Abort System (LAS) is designed to carry the Orion Spacecraft and its crew to safety by propelling them away from the rocket—a maneuver that involves rapid acceleration and intense pressure waves, causing vibrations that must be analyzed well ahead of the mission to ensure the system doesn't shake itself apart. To help summarize the characteristics of these vibrations, CFD experts at NAS, in close collaboration with the Orion Loads and Dynamics team at NASA's Johnson Space Center, are running extensive simulations for various launch abort scenarios using the NAS-developed LAVA software. The team's flight test simulations have accurately predicted the acoustic vibrations on the surface of the LAS when compared to the flight test data, opening the door to more analysis that can help reduce uncertainty that are not physically possible or too expensive to test—further helping to reduce risk and ensure astronaut safety.



Isometric view of the Artemis booster separation event with the Block 1B variant of the Space Launch System. The vehicle surface is colored by pressure contours, where blue is low and red is high. Isosurfaces of high Mach number colored by temperature show the multiple rocket plumes modeled. Jamie Meeroff, Derek Dalle, NASA/Ames

To learn more about aeronautics research at NAS, go to https://www.nas.nasa.gov/areas/launch_vehicle.html

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